

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)	
)	
Amendment of Part 97 of the)	RM-11625
Commission's Rules to Facilitate Use in)	
the Amateur radio Service of Single)	
Slot Time Division Multiple Access)	
Telephony and Data Emissions)	

To: The Commission

Executive Summary

The undersigned commenter(s) wish to thank the Commission for considering this matter. We applaud the ARRL's efforts, in general, to further enhance the ability of amateur radio operators to experiment in alternative modes; however, we feel that the emission based on the Digital Mobile Radio standard, known generically as DMR, or by one or more of its trademarks manufacturer-specific trade names such as MotoTRBO, constitutes one that is already authorized under the current rules sanctioned by 47CFR Part 97. We will further show that there is considerable confusion concerning the proper choice of emission designator by which such emissions, and others, are authorized. There is, in fact, some contradiction within the commercial world with respect to emission designators for identical emissions from products that have been approved for use by the Commission. Additionally, we will show that such confusion stems from the broad nature of emission designators as well as examples given within 47CFR Part 2 of the current rules. Finally, we will show evidence that the mobile and portable DMR-compliant devices utilized by amateurs meet the current Part 97 rules.

We, respectfully, request that the Commission revise and augment the rules by modifying Sections 97.3(c)(5) and 97.307(f)(8), with a singular addition (noted in the next paragraph) as petitioned by the ARRL in their Petition for Rule Making dated March 15, 2011¹ and placed on public notice by the Commission on March 23, 2011; thereby furthering the experimental and development nature of the amateur radio service.

To that end, we request the following amending the rules as outlines in Attachment A of this submission. We request one additional modification in addition to those that were requested by the ARRL: Inclusion of "V" as the third

¹ ARRL Petition for Rulemaking, Amendment of Part 97 of the Commission's Rules to Facilitate Use in the Amateur radio Service of Single Slot Time Division Multiple Access Telephony and Data Emissions; filed March 15, 2011. See: http://www.arrl.org/files/media/News/TDMA_PRM.pdf

symbol would codify simultaneous transmission of voice and data; something that is already in use. In this fashion, several operating modes could be fully supported including simultaneous transmission of location data along with voiced speech intelligence or voice intelligence simultaneous to other data streams. Such capabilities would have beneficial impact in public service applications such as SKYWARN and emergency communications in addition to other non-critical experimentation within the service. While we believe that such emissions are already permitted, clarification in the form of amended 97.3(c) (5) would avoid the possibility of this issue being raised in the future.

We also request clarification by the Commission with respect to our assertion that DMR is already authorized under the current rules and regulations.

While we recognize that this Rulemaking is not the proper venue to support a more generalized revision of the emission designators for spectrum associated with the amateur service, others have commented on this issue²; we also suggest that amateur emissions would be best served as limited by bandwidth with limited reliance to emission format as long as the transmitted information is not encrypted in any form or fashion. For example, with regard to operation on the HF bands, we suggest the following: “CW” portions of the bands should be limited to necessary bandwidths of 350Hz or less; “Phone” portions to 4kHz for all single sideband-type emissions and 9kHz for all double sideband emissions. Above 50.6MHz and below 225MHz, we suggest emissions be limited to 25kHz with some notable exceptions. In the 70cm allocation, emissions should be allowed up to 6MHz provided they comply with prescribed band plans, and above 33cm, the only limitation on bandwidth should be adherence to prescribed band plans. In this fashion, amateurs could be “self-policing”; setting policy as a collective, thereby enhancing the experimental aspect of the service and reducing the regulatory load upon the Commission as new modulation modes are explored. This would, however, be the subject of an independent Notice of Proposed Rulemaking; it should not be part of this NPRM.

Clarification of the ARRL Discussion of DMR

In the original Petition for Rule Making submitted by the ARRL, the League generalized most DMR experimentation within the amateur community as that of Motorola-manufactured equipment, and as sold under the name MotoTRBO. We wish to correct the record on this matter. While Motorola is a large and significant supplier of DMR-compliant equipment, several other manufacturers also produce DMR-compliant equipment including Tait, Hytera, and others. In fact, the DMR Association website³ indicates that nearly 1 dozen manufacturers currently product DMR-compliant equipment. We feel the importance of this point is two-fold:

² Please refer to the comments filed with respect to RM-11625 by JAMES EDWIN WHEDBEE; filed March 23, 2011; posted March 24, 2011.

³ www.dmrassociation.org

1) Discussion and designation of DMR emissions designators is not universal, as will be shown. Nor is it universally certified by the Commission utilizing the emission designator suggested by the League. This, too, shall be shown. Further,

2) It indicates that DMR technology is, unlike the Icom / D-STAR offering, not a single-source technology in the United States, which eases access of this equipment to larger portion of the amateur community; thereby encouraging further experimentation. Finally,

3) As others have pointed out⁴, just as in the case of commercial and government allocations, spectrum crowding is also an issue within the amateur community. New, spectrally efficient modes such as DMR offer increased efficiency by which spectrum is utilized while simultaneously expanding the opportunities to utilize spectrum in the spirit in which the amateur service exists.

Determination and Categorization of RF Emission Designators

The *Emission, modulation and transmission characteristics* used to describe a transmitted signal are found in 47CFR 2.201. Several decades ago, this section was revised to harmonize such designators with those set forth by the International Telecommunications Union, ITU. In doing so, the definitions of described emissions are directly traceable to ITU standards. The Commission does, however, clarify some emissions by granting examples used in the definition of occupied and necessary bandwidth. We suggest that, in some cases, more than one emission designator may be fully descriptive of a radiated emission. This is due to the broad nature of emissions that must be covered by the designators. Further, while the ITU designators were written prior to the “digital era”; more complex digital modulation methods were anticipated in their construction; however, the complexity of signals generated today may often times be described by multiple designators. As will be shown, it is a matter of record that the Commission has approved equipment designed as compliant to the DMR specification with multiple emission designators and that, we feel, all are equally accurate and applicable. Some of this is due to the lack of use of the fourth and fifth symbols, as described by ITU regulations as “optional”, for RF emission designation.

In addition, we argue that the emission, modulation and transmission characteristics of a radiated signal must accurately describe the signal, as emitted, without prior knowledge of the system as a whole, including receivers and retransmission equipment such as repeaters. One must describe the

⁴ Multiple filings in the RM-11625 Proceedings including those of Colorado Council of Amateur Radio Clubs, Inc, Wayne Heinen, and others.

transmitted signal without *a priori* knowledge of the system as a whole for it is the transmitter alone that is capable of the use of spectrum, including interference and other potential concerns.

The reasoning for agnostic description of the radiated signal is manifold. Consider the following discussion:

Commercial medium wave AM broadcast receivers that utilize envelope detection are designed to receive a 20K0A3E signal; however, the actual broadcast signal being sent to the receiver may take the form of a, analog stereophonic broadcast utilizing a combination of amplitude and angular modulation. In this example, a compatible AM stereo signal, would be represented as a 20K0D8E signal. Both are compatible with a receiver designed for the reception of a 20K0A3E signal but knowledge of the receiver does not aid in describing the emission designator, in total, for the actual transmitted signal.

Likewise, a commercial, entertainment quality monaural FM broadcast receiver is designed to receive a signal represented by an emission designator 180KF3E. It is also capable of demodulating, in a compatible fashion, a stereophonic broadcast; the latter represented by 180KF8E.

In both cited cases, the transmission can be properly demodulated by a receiver designed to receive a differing emission albeit with sufficient compatibility. Furthermore, in both cited cases, knowledge of the receiver or communications system as a whole does not provide sufficient information to properly describe the emitted signal. Determination of the radiated signal must, therefore, be independent and agnostic to the complete system.

Determination and Categorization of Amateur RF Emission Designators Including DMR

Repeater / Relay Device

We feel the League is correct in their analysis of the emission from a repeater / relay station transmitter. It is a continuous envelope signal that is frequency modulated and broken into more than one time slot; however, the envelope is constant. Data is conveyed using 4-level FSK modulation as will be described in detail later. Further, one could make the statement that anything less than 2 time slots is not possible; it is by definition Time Division *Multiple* Access. In the case of a DMR repeater, the time slots are as follows (as taken from the published, public ETSI document⁵):

⁵See ETSI TS 102 361-1 V1.2.1 (2006-01)

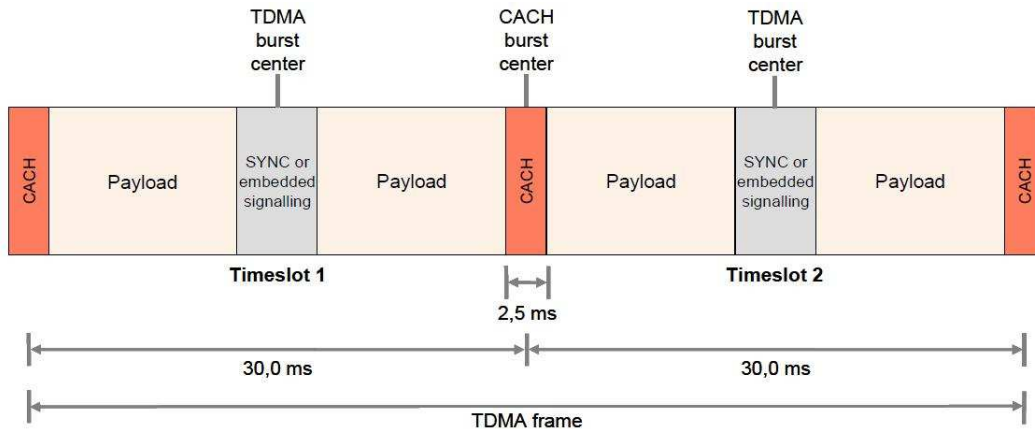


Figure 4.5: BS sourced TDMA frame

It is clear from the figure that each repeater (base station) TDMA frame is comprised of 2 time slots, with embedded synchronization and signaling information plus a 2.5ms guard time at the beginning of each frame as well as between each time slot of each frame. This frame is repeated every 60ms until the transmitter is de-keyed. We feel the League is correct in their analysis that such an emission would be regarded as a 7K60F7D or 7K60F7E defining constant envelope frequency modulation, two or more quantized / digital channels of information conveying data (final designator D) or voice (final designator E). The former is allowed, as stated by the League, under 47CFR 97(c)(5). Designation in this manner also supports our argument to follow in which 47CFR 2.202 gives examples of multi-level FSK emissions and the appropriate designator.

User Transmitter Device

With respect to the user device (handheld / handie-talkie, mobile, or base station radio) that is transmitting only one channel of information, there can be contention over the correctness of the use of designators 7K60F1D/E and 7K60FXD/E if one explores 47CFR 2.201. In fact, one could ascertain from the above figure that, since repeater / relay device has time slots, the user device may also be defined as a single time slot device. But, as pointed out earlier, one must determine the RF emission based solely on the emission of the transmitter; not the system as a whole.

The emission designators were adopted and harmonized to the ITU standard and 47CFR 2.201 lacks definition and detailed descriptions of each designator. One must refer back to the ITU specification to determine the intent of each designator. In another Comment filed with the Commission on this matter, another individual addresses the derivation of the emission designators from the

ITU source⁶. The Commission does, however, offer examples of emissions designators in 47CFR 2.202 Bandwidths:

§ 2.301

47 CFR Ch. I (10–1–09 Edition)

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
Composite transmission digital modulation using DSB-AM (Micro-wave radio relay system). Binary Frequency Shift Keying.	$B_n = 2RK/\log_2 S$	Digital modulation used to send 5 megabits per second by use of amplitude modulation of the main carrier with 4 signaling states $R = 5 \times 10^6$ bits per second; $K = 1$; $S = 4$; $B_n = 5$ MHz	5M00K7
	$(0.03 < 2D/R < 1.0)$; $B_n = 3.86D + 0.27R$ $(1.0 < 2D/R < 2)$ $B_n = 2.4D + 1.0R$	Digital modulation used to send 1 megabit per second by frequency shift keying with 2 signaling states and 0.75 MHz peak deviation of the carrier $R = 1 \times 10^6$ bps; $D = 0.75 \times 10^6$ Hz; $B_n = 2.8$ MHz	2M80F1D
Multilevel Frequency Shift Keying.	$B_n = (R/\log_2 S) + 2DK$	Digital modulation to send 10 megabits per second by use of frequency shift keying with four signaling states and 2 MHz peak deviation of the main carrier $R = 10 \times 10^6$ bps; $D = 2$ MHz; $K = 1$; $S = 4$; $B_n = 9$ MHz	9M00F7D

Specifically, we refer to table presented. The keyed envelope, multi-level emission of a DMR transmitter, as well as the already-allowed constant envelope P25 signal, relies on 4-level FSK⁷. In the case of P25, this is referred to as C4FM. The “tones” / levels for P25 are +1.8kHz, +0.600kHz, -0.600kHz, and -1.800kHz while for DMR they are +1.944kHz, +0/648kHz, -0.648kHz, and -1.944kHz. Constant envelope, multi-level FSK is one of the examples given in the table, reproduced above. It is clear that in the case of multi-level FSK, narrowed in bandwidth to account for the data rate / signaling rate of a DMR device, the Commission has defined such emissions also as 7K60F7D. Furthermore, F1D/E and F2D/E emissions are the only 2 that have restrictions regarding on single-slot TDM; therefore, if DMR, from the standpoint of the user device, is considered per the example given, there would be no restriction with regard to single slot TDM and the use case is already allowed under the present rules.

To differentiate between 4-level FSK, as we believe the example in 47CFR 2.201, Figure 4D in Attachment B, indicates the spectrum of an experimental non-constant envelope, 4 tone (carrier) signal composite modulation in which each carrier is modulated with QPSK data. While we believe that DMR may be properly defined as 7K60D7D modulation where the first symbol D represents the case in which the carrier is sequentially modulated in amplitude and angle caused by 4-level FSK (“7” as the second symbol), the example shown in Figure B4 depicts a signal in which the signal is simultaneously modulated by multiple tones, each comprised of amplitude and angular modulation. In both cases, an

⁶ Ibid 2

⁷ Time and Frequency domain plots of P25, Phase 1 as well as conventional analog narrowband FM are reproduced in Attachment B, Figures B1 and B2.

emission designator suffix of D7D is appropriate. Note also that the signal shown in Figure B4 can not be properly depicted by the suffix F7D; the example in the table, above, must refer to an emission where multilevel, constant envelope FSK is utilized.

There exist several examples of Multi-level FSK that is already accepted and in use in the amateur radio service. Examples of multi-tone FSK are **FSK441**, **JT6M** and **MFSK16**⁸. If we follow the guidance of 47CFR 2.201, DMR emissions are defined as shown and are currently permissible by emission designation as well as tacitly by the unrestricted use of multi-level FSK modulations in the amateur community today and over the past decade or more.

The Illustrative Nature of 47CFR 97.307

If one does go as far as to characterize the single channel DMR transmission as a single slot TDM signal, the position suggested by the ARRL wherein “...an examination of the definitions in Section 97.3(c) and the broad classifications of permitted emissions per band in Section 97.305 does not reveal any intention to exclude single slot TDMA emissions from the amateur service at VHF or UHF, and no justification seems to exist for that exclusion”⁹ is shared by us.

As pointed out by Whedbee in his comments filed on this matter¹⁰, there exists an incongruity between Part 2 and Part 97. In addition, he points out, and we concur, “Likewise, ARRL’s Petition correctly points out that Section 97.307 (47 CFR§97.307) is unclear whether or not single slot TDMA telephony is authorized; however, as ARRL makes abundantly clear, Section 97.307 seems clearly to be illustrative rather than controlling” (emphasis added).

Further Considerations Defining DMR RF Emissions

The undersigned commenter(s) further believes that there are additional considerations when determining the emission designator of a DMR-compliant transmitter.

⁸ **FSK441** uses four-tone frequency shift keying at 441 baud. The frequencies of the audio tones are 882, 1323, 1764, and 2205 Hz.

JT6M uses 44-tone FSK with a synchronizing tone and 43 possible data tones — one for each character in the supported alphanumeric set, the same set used for FSK441. The sync tone is at $1102500/1024 = 1076.66$ Hz, and the 43 other possible tones are spaced at intervals of $11025/512 = 21.53$ Hz up to 2002.59 Hz.

MFSK16 is intended for computer use, and is generated and received using the standard PC sound facility, for use with an SSB transceiver. Two modes are offered, MFSK16 (15.625 baud 16-FSK, 15.625Hz spaced tones) and MFSK8 (7.8125 baud 32-FSK, 7.8125Hz spaced tones).

⁹ Ibid 1

¹⁰ Ibid 2

In the case of a mobile or portable device utilizing one voice or data channel, the transmitter is keyed and de-keyed at a 30ms rate with a 30ms dead time between subsequent transmissions. This represents a 33Hz envelope modulation term. Just as in shaped CW keying (to limit bandwidth), it is not a square wave; pulse shaping is utilized to constrain the bandwidth of the emitted signal. If the transmitted signal contained no other information other than the On-Off Keying (OOK), it would be best represented as a simple 100HA1N (assuming no information was actually inferred) or 100HA1D (assuming that the on-off keying was utilized to control or command data to a receiver) emission. This designation is accurate since the transmitter is amplitude modulated (On-Off Keyed in this case); therefore the nature of the main signal is amplitude modulation in it's simplest form, the nature of the signal is that it contains one channel of information, and the information is either null or data transmission, telemetry, or telecommand.

Next, consider a transmission in which the transmitter is keyed in amplitude and angularly modulated (frequency or phase). Specifically, consider the period which the envelope is keyed to the On state and information is angularly modulated. If one did not know that the radio was in communications with a TDMA (multi-slot) base station / repeater, the RF emission would simply analyzed as a simultaneous application of amplitude (OOK) and phase / frequency modulation. Since only 1 channel of information is conveyed, the proper designators for such an emission would be: 7K60D1D (for a single channel of data) or 7K60D1E for a single channel of voice. The latter is currently allowed under 47 CFR 97.3 (c) (5). In this case, the first "D" is defined in 47 CFR 2.201 as an *"Emission in which the main carrier is amplitude and angle modulated either simultaneously or in a pre-established sequence (emphasis added)."* The second designator, 1, is accurate since the transmitter itself is not multiplexing multiple signals; it is sending only one channel of information utilizing OOK and angular modulation. In fact, it is our opinion that when the definitions were drafted, it was realized that a single channel TDMA multiplex presented an inaccurate description; all examples of TDM signals that can be found in the ITU regulations involve multiple data streams sequentially multiplexed onto a single carrier or subcarrier. One could draw from this that the ITU regulations, when formulated, viewed a single channel of information, imposed on a On-Off keyed signal as a signal different than a TDM emission, similar to that as we have above. Rather, such as transmission would always appear as an OOK signal incorporating other envelope and phase characteristics. When the transmitter is keyed, it is conveying information that is pertinent to the singular information present. Since the mobile / portable device is obtaining its timing information from the base station / repeater, the OOK envelope does not convey data to the base station / repeater. Therefore, the only information present is the voiced data along with ancillary data required to reconstruct the signal at the distant receiving point. Essentially, the transmitted signal is, in fact one of an emission type that is best described as 7K60D1D/E or,

in light of the example given in 47CFR 2.202, 7K60D7D/E; the former final symbol being for a data transmission and the latter being for a digitized voice transmission. The time and frequency domain depictions of the DMR signal are shown in Attachment B, Figure B3.

Further discussion: When the user radio does transmit, it does not further break it's channel into multiple slots. While that is certainly possible, and would constitute TDM, the user radio actually interrogates the channel much like a conversation or QSO, would originate on a given frequency or channel. The radio has no idea of time slots when first keyed. It sends a burst of information to the repeater, or in the case of a direct, simplex, communication, to another user radio. The second user radio or repeater then replies back with its message and the communication session continues until the radio is de-keyed. Lacking *a priori* knowledge of the system, one would realize that, just in any radio exchange of intelligence, a sequential sharing of the channel exists. The only difference between the DMR transmission and any other voice, CW, or 2-way exchange of information is the rate at which the channel sharing takes place; the rules give no guidance over the rate of exchange except that it must not cause the signal to exceed a prescribed bandwidth limitation.

When viewed in this fashion, the exchange between DMR devices when only one channel of information is exchanged, is no different than, say, that of other long-used systems such as the NCDXF/IARU propagation beacon system. In the NCDXF/IARU beacon system¹¹, 18 time slots are distributed uniformly over a 3 minute period by 18 stations worldwide. Data is sent via on-off keying and varying amplitude levels. Using the analogy suggested by some concerning single-slot TDM signaling, the emission from each beacon should be 30H0AXA. We, however, believe that, in similar fashion to our assertion over proper designation of a DMR emission, the correct emission designator for the NCDXF/IARU beacon would be 30H0A1A regardless of the fact that, as an overall system, it is a time-slotted, multiple access system. From the standpoint of each transmitter, it is simply on-off keying with intelligence information contained in the payload. The legality of the NCDXF/IARU beacon system has not come into question; nor are we suggesting it should. Our example is illustrative.

Complete ITU designators provide a means to absolutely determine the characteristics of a radiated emission. Two additional designators are defined by the ITU. The Commission, however, does not require the use of these "fourth and fifth" symbols.¹² The fifth symbol is utilized to describe the multiplex system in use: **N**one, **C**ode, **F**requency, **T**ime, **C**ombination (**W**), or **O**ther (**X**). One could ascertain that, by the action taken by the Commission at the time of

¹¹ <http://www.ncdxf.org/beacon/earlyhistory.html>

¹² 47CFR 2.201 Note: "A fourth and fifth symbol are provided for additional information and are shown in Appendix 6, part A of the ITU Radio Regulations. Use of the fourth and fifth symbol is optional. Therefore, the symbols may be used as described in Appendix 6, but are not required by the Commission."

adoption and harmonization of the designators with ITU as to not require or include a requirement for such designation in the emission designator, the form of multiplex in use is unimportant with respect to the emission designator.

Non-Uniformity of Part 90 Certified Devices

The Commission has provided us with guidance with regard to classification of emissions from DMR devices. The ARRL has pointed out that one DMR product manufacturer, Motorola, has obtained certification under Part 90 for DMR product that can be operated in multiple modes. The Motorola product is certified using but 2 designators for all possible DMR emissions: 7K60FXD and 7K60FXE. In a similar fashion, Hytera also currently markets product in the US that is also certified using similar emissions designators. We believe that, as the ARRL has already pointed out, that the second symbol “X” is used as a “catch-all” designator under certain circumstances¹³. Thus, the suffix FXD/E is merely states that these radios, when operated in Part 90 and other services, may emit a variety of modes. The operating license of a given entity determines what modes are acceptable for use by a given licensee.

On the other hand, Tait, also a provider of DMR equipment in the US, has certified their equipment by means of multiple emissions: **10K0F1D, 10K0F1E, 10K0F7D, 10K0F7E, 11K0F3E, 12K7F1D 16K0F3E, 6K60F2D, 7K70F1D, 8K10F1D, 8K10F1E, 8K10F7D 8K10F7E, 9K60F2D.**

These designators that describe each possible mode individually rather than in blanket fashion. Since all products manufactured for DMR conform to the same, identical standard, we must believe that the certified data is accurate and acceptable. This would support our argument that a single slot TDM signal does not adhere to the intent of the adopted and harmonized ITU RF emissions designators. We do not suggest that any product offering is invalid; we simply argue that there are multiple “correct” methods to describe a radiate signal when advanced modulation methods are utilized. Attachment “C” is a copy of a product datasheet for one example of a Tait DMR product.

A second case supporting our position that “single slot” TDM does not “fit” ITU emissions designators is presented by the Thales “Tracs” product. While not certified in the US (as far as we know from the literature), it is approved for use in Europe and conforms to the ITU emissions designators as specified on their datasheet. This product is billed as a TDMA, fleet tracking device. It sequentially transmits location information based on a time slot assigned via GPS and/or system timing. Since the radio operates on a single, repetitive time slot, it’s emission is not TDM as we suggested is the case for a user DMR device earlier. Rather, the Thales device is type approved utilizing the following RF emission

¹³ Ibid 1. Section 7, page 6 “Therefore, the “X” second symbol is a catch-all, rather than a substantive classification of emission type.” (Emphasis added).

designators: 25K0F1D/12K5F1D. A datasheet for the Thales product is affixed to this filing as Attachment "D".

**Determination of Operating Modes and RF Emissions in the
Amateur Radio / Part 97 Radio Service; Self-Certification; "Mission Statement" of the
Amateur Radio Service**

Amateur Radio is unique in that it allows amateur radio operators to design, build, modify, and operate radios that have not necessarily been authorized by the Commission.¹⁴ Of course, all rules set forth in Part 97 must be met. The amateur must insure that when he programs, modifies and, in general, utilizes equipment in the amateur space and allocations, it complies with Part 97 regulations. The undersigned feel that this condition has been met through our discussion of the utilized DMR emission. Further, DMR use in amateur allocations is in the spirit of "selecting (and utilizing) channels to make the most efficient use of the frequencies,"¹⁵ "...to contribute to the advancement of the radio art"¹⁶, and "...advancing skills on both the communication and technical phases of the art."¹⁷

The Six Meter FM Club of Crystal Lake, IL

Our group operates interconnected repeaters and remote receive sites, located at various commercial and residential sites, in the Northeast Illinois region. We currently have systems on 6 meters / 52MHz, 2 meters / VHF, 1.25 meters (222MHz), and 70cm / UHF. Included in these systems are APCO-compliant P-5 systems on VHF and UHF, D-Star on UHF, and IP Site-Connected DMR on UHF along with analog systems on each band. Our charter is to provide communications for emergency and volunteer efforts as needed as well as routine day-to-day communications by and for the amateur radio community. We also strive to further the art of radio communications. To that end, we believe that experimentation with new modulation and systems methods, including digital voice modes and interconnect of these systems by multiple means including RF, VoIP, and system-specific protocols such as IP Site Connect for DMR, furthers the charter of amateur radio. To that end, we support the proposed Rulemaking including those changes outlines in Attachment A.

¹⁴ FCC WTB website; <http://wireless.fcc.gov/services/index.htm?job=about&id=amateur> "Station control operators cooperate in selecting transmitting channels to make the most effective use of the frequencies. They design, construct, modify, and repair their stations. The FCC equipment authorization program does not generally apply to amateur station transmitters."

¹⁵ Ibid 14

¹⁶ 47CFR 97.1(b)

¹⁷ 47CFR 97.1(c)

Conclusions, Recommendations, and Closing Comments

- 1) The undersigned commenter(s) support the requested changes petitioned by the ARRL with added expansion of Section 97.3(c)(5) and 97.307(f)(8) as listed in Attachment A.
- 2) The undersigned commenter(s) conclude that DMR emissions are already allowed under current Part 97 Rules and regulations and request Commission concurrence on this matter.
- 3) The undersigned commenter(s) further remark that experimentation with and adoption of spectrum efficient modulation methods further the hobby, provide additional access to limited allocations, and provide greater flexibility in performing public service roles such as Skywarn, emergency communications, and assistance during disaster relief efforts. Furthermore, there is essentially no risk in codifying the requested rules into the Part 97 Rules and Regulations.
- 4) DMR occupies approximately ½ the bandwidth of current analog, 5kHz deviation FM modulation yet provides twice the voice capacity or a combination of voice and data with identical coverage. Experimentation of new modes, including DMR further advance the art of amateur radio and are within the charter of the service and should be encouraged. Use of bandwidth-efficient modes is within the spirit of the amateur service regulations.
- 5) Assigning RF emission designators to modulation methods utilized today should be based on individual emissions from transmitting devices; without knowledge of the overall radio communication system. Multiple, appropriate designators may exist; the amateur service would be better served by limitations based on occupied bandwidth, non-use of encryption or other techniques utilized to make transmissions covert, and blanket disallowance of certain emissions based on spectral allocation (ex: pulse).

Respectfully submitted,

(Gregory J Buchwald)

On behalf of: Six Meter FM Club of Crystal Lake (K9VI), by

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Attachment A

PROPOSED RULE CHANGES:

Part 97 of Chapter I of Title 47 of the Code of Federal Regulations is proposed to be amended as follows:

Section 97.3(c) is amended to modify certain definitions, to read as follows:

§97.3 Definitions.

(c) The following terms are used in this part to indicate emission types. Refer to Section 2.201 of the FCC Rules, Emission, modulation and transmission characteristics, for information on emission type designators.

(5) Phone. Speech and other sound emissions having designators with A, B, C, D, F, G, H, J or R as the first symbol; 1,2,3,7,8,9 or X as the second symbol; E or W as the third symbol. Also MCW for the purpose of performing the station identification procedure, or for providing telegraphy practice interspersed with speech. Incidental tones for the purpose of selective calling or alerting or to control the level of a demodulated signal may also be considered phone.

Section 97.307(1) is amended to read as follows:

§ 97.307 Emission standards.

(f) The following standards and limitations apply to transmissions on the frequencies specified in § 97.305(c) of this Part.

(8) A RTTY or data emission having designators with A, B, C, D, E, F, G, H, J or R as the first symbol; 1,2,7,9 or X as the second symbol; and D or W as the third symbol is also authorized.

Attachment B

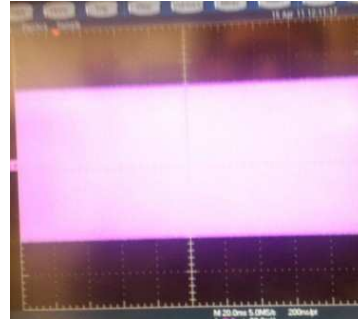
Frequency Domain

Time Domain

Figure B1: Analog NBFM (5kHz Dev) with PL 20K0F3E; 16k0F3E

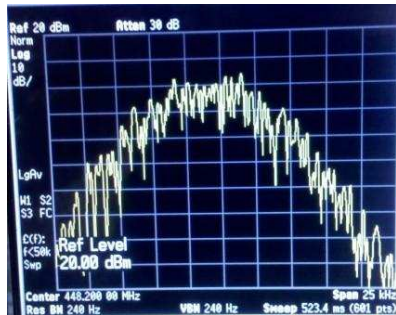


25kHz Horizontal Span
10dB/div Vertical

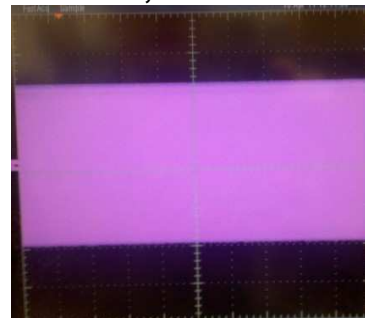


Constant Envelope
448.475MHz Carrier

Figure B2: P25 Digital (12.5kHz, Phase 1); 10K0F1D/E; 8K10F1D/E



25kHz Horizontal Span
10dB/div Vertical

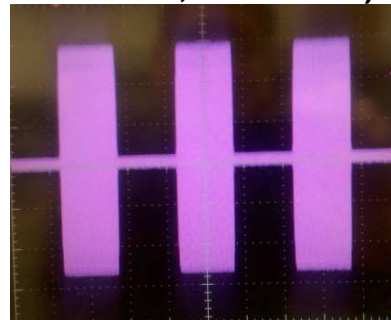


Constant Envelope, C4FM
448.200MHz Carrier

Figure B3: DMR; Repeater Mode User Device (7K60D1D/E; 7K0D7D/E)
(Current Part 90 Accepted Designators: 7K60FXD/E; 7K60F1D/E)



25kHz Horizontal Span
10dB/div Vertical



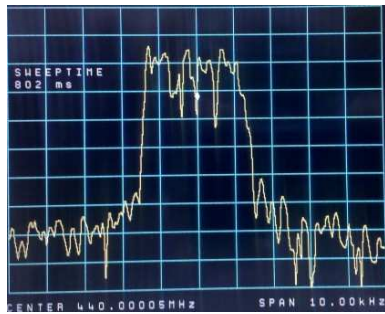
30ms OOK; 4-Level FSK During
“On”Period; 448.79375 MHz Carrier

Attachment B, Continued

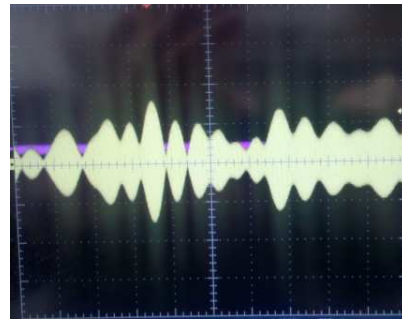
Frequency Domain

Time Domain

Fig. B4: 4-Tone (Carrier); each with QPSK Modulation 3K00D7D



**10kHz Horizontal Span
10dB/div Vertical Axis**



**Non-Constant Envelope
440.003 MHz f_o**

Attachment C



TM9135

SPECIFICATIONS



TM9135 P25 Mobile radio shown with standard microphone

P25 TRUNKED AND CONVENTIONAL MOBILE RADIOS FOR NON-FRONTLINE USERS

TM9135 mobile radios provide affordable and reliable digital communications for non-frontline users who need exceptional audio clarity without provision for all possible features or configurations.

Tough, reliable and interoperable

- Radios can be used on analog, P25 conventional, trunked and simulcast networks
- Out of the box and onto the shift - the TM9135 is a radio designed for fast integration onto a digital network (the P25 CAI is included)
- Hand-held control head (HHCH) option
- Ease of operation: all user controls and menu functions are identical across all the Tait P25 portables, mobiles and HHCHs
- Tested beyond MIL-STD-810C, D, E and F
- Context-sensitive and programmable menu/function keys
- Supports individual, group, broadcast and emergency calls
- Lat/long coordinates displayed on screen (requires GPS receiver and software licenses)*
- Advanced voting optimizes channel reception
- User programmable scan
- Comprehensive scanning features including P25 talk-group, priority, dual priority and editable scanning
- The TM9135 mobile (including HHCH) is available in colored options in addition to the standard black**

*Software license option(s) available separately

**Please contact your local Tait representative for more information on color options

Tait Tough radio

Reliable and durable TM9135 mobile radios have been built to withstand the extremes of nature. A high temperature display option on Tait mobiles optimizes screen visibility in hot environments.

Interoperability assured

Genuine open standards ensure choice, value and responsiveness during routine operations or crises.

Digital audio clarity

Crystal clear digital audio allows precise communication even in noisy situations.

Analog operation for phased transition

Protect your current analog investment and migrate to P25 at your own pace. Analog mode allows communication between various partner agencies signaling options including MOC1200 encode/decode and Two Tone decode.*

Tailored functionality

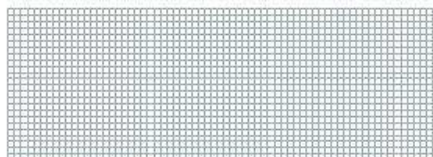
This radio will provide the essential network performance required by non-frontline users. For more advanced functionality users should consider investing in the TM9155 for long term flexibility.

*separately enabled option





Above: Colored TM9135 HHCHs shown in red, green and yellow*.
*Please contact your local Tait representative for more information on color options.



Regulatory Data

USA	VHF	CFR 47 Parts 22, 90.210, 74, 90, 95
	UHF	CFR 47 Parts 22, 90.210, 74, 95A, 90
Canada	800MHz	CFR 47 Parts 22, 90
		RSS-119
Europe		EN300 085, EN300 113
		EN301 489
Australia/New Zealand		EN60950
		AS/NZS4295
Type Approval	FCC	Industria Canada
	NTIA	
25W	VHF	CASTMAH1E 737A-TMAH1E
	UHF	CASTMAH5E 737A-TMAH5E
30/35W	UHF	CASTMAH6E 737A-TMAH6E
		CASTMAH5F 737A-TMAH5F
40W	UHF	350-400MHz*
		380-420MHz*
50W	VHF	CASTMAH5F n/a
		CASTMAH7F n/a
110W (ERPFA)	VHF	CASTMAH1F n/a
		CASTMAH1Z n/a
Emission Designators		10K0F1D, 10K0F1E, 10K0F7D,
		10K0F7E, 10K0F5E, 10K0F1D,
		10K0F3E, 6K0F0D, 7K0F1D
		8K10F1D, 8K10F1E, 8K10F7D
		8K10F7E, 9K0F0D

Specifications are subject to change without notice and shall not form part of any contract. They are issued for guidance purposes only.
*Please note that not all frequency bands are available in all markets. For further information please check with your nearest Tait office or authorized dealer.
**Receiver preamplifier installed.
The word "Tait" and the Tait logo are trademarks of Tait Electronics Ltd.
Tait is an ISO 9001:2008 and ISO 14001:2004 certified supplier.
It is important to note that this product does not offer encryption capability and there is no upgrade path for this. If encryption may be required Tait recommends the TM9555 mobile radio.



ISO 9001
ISO 14001

AUTHORIZED DEALER

26011190

TM9135 Specifications

General			
Frequency Ranges	Frequency Band*	Transmit Power	Transmit Current (Typical)
VHF	136-174MHz	25W	<5.5A
	136-174MHz*	50W	<10.5A
	136-174MHz	110W	<30A
UHF	250-400MHz*	40W	<8.5A
	380-420MHz*	40W	<8.5A
	400-470MHz	25W	<6.5A
	400-470MHz	40W	<8.5A
	450-530MHz	25W	<6.5A
	450-520MHz	40W	<8.5A
700/800MHz	Transmit 762-778MHz 792-828MHz 850-870MHz	Receive 762-778MHz 792-828MHz 850-870MHz	30W (<800MHz) 35W (>800MHz) <10A <10A
Frequency Stability ±1.5ppm (-20°C to 140°F / -30°C to 60°C)			
Channel/Zones 1,000 channels/30 zones			
Talk-groups 26 talk-group lists comprised of up to 50 members each			
Scan Groups 300 with up to 50 members each, maximum of 2,000 members total			
Power Supply 10.8-16VDC			
Channel Spacing 12.5/15/20/25/30kHz			
Frequency Increment/Channel Steps 2.5/5/6.25			
Dimensions (DxWxH) Control Head 1.98 x 1.24 x 2.9in (50 x 31 x 75mm)			
Dimensions (DxWxH) Radio Body 25W 6.9 x 6.3 x 2.1in (175 x 160 x 52mm)			
30/35/40/50W 7.7 x 6.3 x 2.1in (195 x 160 x 52mm)			
110W 14.6 x 9.8 x 5in (370 x 250 x 127mm)			
Weight Control Head 11.6oz (330g)			
Weight Radio Body 25W 42.9oz (1200g)			
30/35/40/50W 49.4oz (1400g)			
110W 296oz (8400g)			
Operational Temperature -20°F to 140°F (-30°C to 60°C)			
Sealing IP54 dust and rain			
RF Connector 50 Ohm BNC or Mini UHF			
Interface Connectors 3 Interface Connectors with Serial Ports			
Analog Signaling Options MOCL200 encode/decode, Two Tone decode, PL (CTCSS), GPR, (DCS)			
Military Standards 810C, D, E and F			
Applicable MIL-STD	Method	Procedure	Procedure
Low Pressure	25/30/35/50/110W	25/30/35/50W	110W
	500.4	2	2
High Temperature	501.4	1	2
	502.4	1, 2	2
Low Temperature	503.4	1	1
	504.4	1	1
Temperature Shock	505.4	1, 3	3
	506.4	1	1
Solar Radiation	507.4	1	1
	508.4	1	1
Rain	510.4	1	1
	511.4	1	1
Humidity	512.4	1, 8	8
	513.4	1	1
Salt Fog	514.4	1	1
	515.4	1	1
Dust	516.4	1	1
	517.4	1	1
Vibration	518.4	1	1
	519.4	1	1
Shock	520.4	1	1
	521.4	1	1
Transmitter			
Output Power	VHF/UHF (TIA/EIA 102 and 603a)	700/800MHz (TIA/EIA 102 and 603a)	
25W	25W, 12W, 5W, 1W	30W, 15W, 5W, 2W	
30W		35W, 15W, 5W, 2W	
35W			
40W	40W, 20W, 15W, 10W		
50W	50W, 25W, 15W, 10W		
110W	110W		
Modulation Limiting	±5kHz	±5kHz	
25/30kHz channel	±2.5kHz	±2.5kHz	
12.5kHz channel			
PM Hum & Noise (typical)	-43dB	-40dB	
25/30kHz channel	-38dB	-33dB	
12.5kHz channel			
Conducted Emissions (typical)	-65dBc	-75dBc	
Audio Response (Analog)	300-3000Hz ±1/-3dB		
Audio Distortion	< 3% at 1kHz 60% deviation		
Transmit Attack Time (TIA/EIA 102)	50ms		
Receiver (typical figures shown)			
Analog Sensitivity	VHF/UHF	VHF 50W	VHF 110W
12dB SINAD	0.28µV (-118dBm)	0.315µV (-117dBm)	0.25µV (-119dBm)
Digital Sensitivity (TIA/EIA-102)	0.28µV (-118dBm)	0.235µV (-120dBm)	0.18µV (-122dBm)**
59dBFS	0.22µV (-120dBm)	0.235µV (-120dBm)	0.18µV (-122dBm)
Intermodulation Rejection (TIA/EIA 102)	-75dB	-75dB	-75dB
Adjacent Channel Selectivity	-75dB	-75dB	-75dB
25/30kHz channel (TIA/EIA 603a)	-65dB	-60dB	-65dB
12.5kHz channel (TIA/EIA 102)	-65dB	-60dB	-65dB
Spurious Response Rejection	-75dB	-60dB	-75dB
PM Hum & Noise	-43dB	-43dB	-43dB
25/30kHz channel	-40dB	-40dB	-40dB
12.5kHz channel			
Residual Audio Noise Ratio	45dB	45dB	45dB
Audio Distortion @ Rated Audio (3W)	3% @ 1kHz 60% modulation		
Optional External Speaker Output	10W (into 4 Ohm)		

Attachment D



Tracs-TDMA is an intelligent radio data network which integrates advanced UHF and VHF communications with GPS technology. Offering outstanding configuration flexibility, and the advantages of unique automatic repeater capabilities, Tracs-TDMA is ideal for complex tracking and communications tasks including:

- Vessel tracking
- Vehicle tracking
- Personnel tracking
- Fleet management
- Port vessel monitoring
- Geophysical field operations management

Key user benefits of Tracs-TDMA

- Real time mobile tracking with either Real Time Kinematic or standard DGPS accuracy
- System provides continuous location of all mobile units 'at a glance'
- Auto adaptive repeater mode extends operating range in areas where direct communications is obstructed
- Advanced technology permits reliable signal transmission in difficult conditions without operator intervention
- Use of messaging facility for the broadcast of navigational instructions such as waypoints and guard zones reduces voice radio traffic and speeds communications
- Advanced error correction as standard
- Emergency alarm for vehicle/operator security



www.thales-tracs.com

THALES

Technical Specification

Channelisation format:	TDMA (Time Division Multiple Access)
Range:	Line of sight operating ranges with integrated power output options of up to 10W
Frequency bands:	VHF 136 - 174MHz UHF 440 - 512MHz
Number of channels:	The transceivers are configured to use any 10 channels in the band with the system configuration software
Transmitter power output:	10mW, 500mW or 2W software selectable, optional 10W integral PA
CCIR emission designator:	25KOF1D/12K5F1D
Error correction:	Byte level Hamming (12,8) code, correcting 1 bit per byte, interleaved into blocks of 20 bytes
Antennae	
Standard:	Integrated GPS and VHF/UHF with single cable, max power 10W
GPS:	L1(1.575GHz), Gain 40dB, 5V DC, Azimuth 360 deg, Zenith 0 deg to 90 deg
VHF:	136MHz to 174MHz, -0.3dBd with optional radials, -3dBd surface mounted
UHF:	440 - 512 MHz
Optional:	Separate GPS and VHF/UHF antennae
GPS receiver	
Standard:	8 channel receiver
High accuracy:	12 channel receiver
Precision:	Real Time Kinematic
Power supply:	9V to 36V DC. Load dump protection to 250V
Power consumption	
Maximum:	Transmit (2W PA, 100% duty cycle) 12W Transmit (10W PA, 100% duty cycle) 40W Receive 4W
Typical:	Transmit (2W PA, 1 report/sec) 5W Transmit (10W PA, 1 report/sec) 7W
Temperature:	Operating -30 °C to +60 °C Storage -45 °C to +70 °C
Waterproofing:	Tracs-TDMA and antenna IP 67 compliant. Dust proof with short term immersion to 1 metre GeoPod IP 68 compliant. Dust proof with immersion to 10 metres
Dimensions and weight:	TDMA: L 246mm W 140mm H 95mm, 3kg GeoPod: L 603mm Diam 90mm, 4.5kg Excluding connectors with cables
Type Approval:	TDMA: Meets ETS 300-113, CE approved GeoPod: Meets UK MPT 1329 band 458.5 to 458.8 MHz, CE approved

THALES

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